Zambia Integrated Systems Strengthening Program

Malaria Active Surveillance System with Active Case Detection and Response: Enhancing Malaria Surveillance in Lusaka District, Zambia

November 2010

This publication was produced for review by the United States Agency for International Development. It was prepared by Zambia Integrated Systems Strengthening Program.

Recommended Citation: Zambia Integrated Systems Strengthening Program. November 2010. *Malaria Active Surveillance System with Active Case Detection and Response: Enhancing Malaria Surveillance in Lusaka District, Zambia*. Bethesda, MD: Zambia Integrated Systems Strengthening Program, Abt Associates Inc.

The Zambia Integrated Systems Strengthening Program is a technical assistance program to support the Government of Zambia. The Zambia Integrated Systems Strengthening Program is managed by Abt Associates, Inc. in collaboration with American College of Nurse-Midwives, Akros Research Inc., Banyan Global, Johns Hopkins Bloomberg School of Public Health-Center for Communication Programs, Liverpool School of Tropical Medicine, and Planned Parenthood Association of Zambia. The project is funded by the United States Agency for International Development (USAID), under contract GHH-I-00-07-00003. Order No. GHS-I-11-07-00003-00.

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Malaria Active Surveillance System with Active Case Detection and Response: Enhancing Malaria Surveillance in Lusaka District, Zambia

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Abbreviations/Acronyms

ACD	Active Case Detection
ACS	Active Case Surveillance
CHW	Community Health Worker
DDT	Dichloro-Diphenyl-Trichloroethane
DHMT	District Health Management Team
DHO	District Health Office
EHT	Environmental Health Technician
HIA	Health Impact Assessment
HMIS	Health Management Information System
ICT	Information Communication Technology
IEC	Information, Education and Communication
IMaD	Improving Malaria Diagnostics Project
IPD	In-Patient Department
IRS	Indoor Residual Spraying
ITN	Insecticide-Treated Mosquito Nets
LLINs	Long Lasting Insecticide Treated Nets
M&E	Monitoring & Evaluation
MACEPA	Malaria Control and Evaluation Partnership in Africa
MIS	Malaria Indicator Survey
MOH	Ministry of Health
NMCC	National Malaria Control Centre
OPD	Out-Patient Department
OTSS	Outreach Training and Support Supervision
PCD	Passive Case Detection
PMI	President's Malaria Initiative
QA	Quality Assurance
RDT	Rapid Diagnostic Test
RDT+	Positive Rapid Diagnostic Test
SMS	Short Messaging Service
TWG	Technical Working Group
USAID	United States Agency for International Development

1. Purpose

The purpose of these activities is to pilot the addition of active malaria surveillance and active malaria case detection (ACD) to the currently ongoing passive case detection (PCD) surveillance system where symptomatic patients are diagnosed and treated at health facilities.
During the active malaria surveillance phase of this project (Phase 1), the National Malaria Control Centre (NMCC), Lusaka District Management Team, Lusaka District health facilities and key stakeholders will seek to improve the accuracy of malaria diagnostics and case reporting in Lusaka District. Activities will include microscopy quality assurance and training activities at health facilities. Phase 1 activities will also include retrospective reporting of all laboratory confirmed as well as suspect malaria cases with ongoing auditing to assure accuracy, fullness and completion of reporting. The active malaria surveillance component will track how quality improvement in diagnostics and reporting affects the trends in malaria cases.

ACD (Phase 2) will be added to five selected pilot health facilities once diagnostics and reporting at the clinic level have been improved, as determined by quality assurance measures. As the pilot transitions to the addition of ACD, an intervention team will visit the households of individuals who have been diagnosed with rapid diagnostic test (RDT) or microscopy-confirmed malaria at the participating health facilities. Family members and neighbors of the index case will be tested for malaria parasites with RDTs and treated with antimalarials as necessary. Based upon results of the ACD response, malaria interventions will be implemented in households and surrounding areas where risk of transmission has been demonstrated.

The addition of ACD to the pilot will be used to systematically detect and treat asymptomatic Plasmodium parasite carriers and has the potential to:

1) further reduce the pool of parasites available to infect vector mosquitoes, and
2) continue to limit the cycle of malaria transmission.

The implementation of an active surveillance with ACD response is a rational method to target costly interventions like indoor residual spraying (IRS) to high risk areas, versus continuing universal coverage of IRS in settings reporting low parasitemia prevalence like that of urban Lusaka District. This surveillance strategy may play an important role in the sustained effort towards malaria transmission reduction in Lusaka District, especially as the malaria control strategy in Lusaka transitions to malaria elimination or pre-elimination [10].

To ensure the success of the pilot project, significant groundwork must be laid during Phase 1, prior to the initiation of active case detection. This groundwork includes training and mentoring of facility personnel on the topics of malaria diagnostics, data collection and reporting. These concepts will be strengthened during Phase 1 of the project and continual training, quality control and evaluation will seek to ensure quality diagnostics and complete and accurate reporting of data throughout the project.

2. Background

The Ministry of Health (MOH), through the NMCC, has achieved widespread coverage of malaria prevention and intervention services through recent national scale-up efforts. The IRS program alone has expanded significantly within the past 5 years. Due to Lusaka's population size and total number of household structures, about 17% of the total IRS resources are dedicated to the Lusaka District IRS campaign. Recent data shows, however, that there are relatively low parasitemia levels in urban areas

like Lusaka District. The National Malaria Indicator Surveys (MIS) in 2006 and 2008 indicated that malaria parasitemia among children under 5 in Lusaka Province is less than 2% in both periods [1, 2]. Preliminary results from the 2010 MIS indicate even lower parasitemia rates. This data supports the claims that preventive actions – including aggressive IRS activities, case management with artemether-lumefantrine (Coartem®), and long lasting insecticide treated nets (LLINs) – have contributed to the drastic reduction of parasitemia rates and severe anemia in children under 5 years of age.
The low parasitemia levels in Lusaka District indicate that this area, along with others of similar epidemiological status, is entering a "transition" stage where intervention management strategies may require modification to ensure efficiency and efficacy. Strategic alternatives to universal IRS coverage that would better serve efforts to advance Lusaka District toward malaria transmission reduction and/or elimination are being considered by the NMCC Monitoring & Evaluation Technical Working Group (M&E TWG) and related partner initiatives. Enhancement of surveillance mechanisms has been identified by this group as an important key to effectively and efficiently continue to reduce the malaria burden [3]. If clean, accurate malaria surveillance data are rapidly transmitted to all levels of malaria control programming, program managers have the information necessary to make prompt and accurate decisions to target limited intervention resources to areas most at need.

The M&E TWG has identified several priority areas to direct these surveillance enhancements, elaborated in "Improving Malaria Surveillance - Concept Paper Version 1.1" [3]. In Lusaka District specifically, efforts will converge around the development of two-phase pilot project including active case surveillance (ACS) and ACD and response (Figure 1). Phase 1, ACS, will focus on the monitoring and quality control of malaria diagnostics and data reporting practices at health facilities and will further improve and standardize malaria surveillance. Phase 2, the ACD and response, will concentrate on malaria case (symptomatic and asymptomatic) and foci detection followed by timely and targeted intervention activities to limit continued malaria transmission. Both Phase 1 and Phase 2 will complement and integrate with ongoing passive case detection at health facilities. Along with the primary goal of reducing or eliminating transmission, an ACS-ACD system has the potential to greatly reduce the cost of IRS campaigns in Lusaka District by changing the program from complete house-to-house IRS coverage, to targeted, focal responses to actively detected malaria cases.

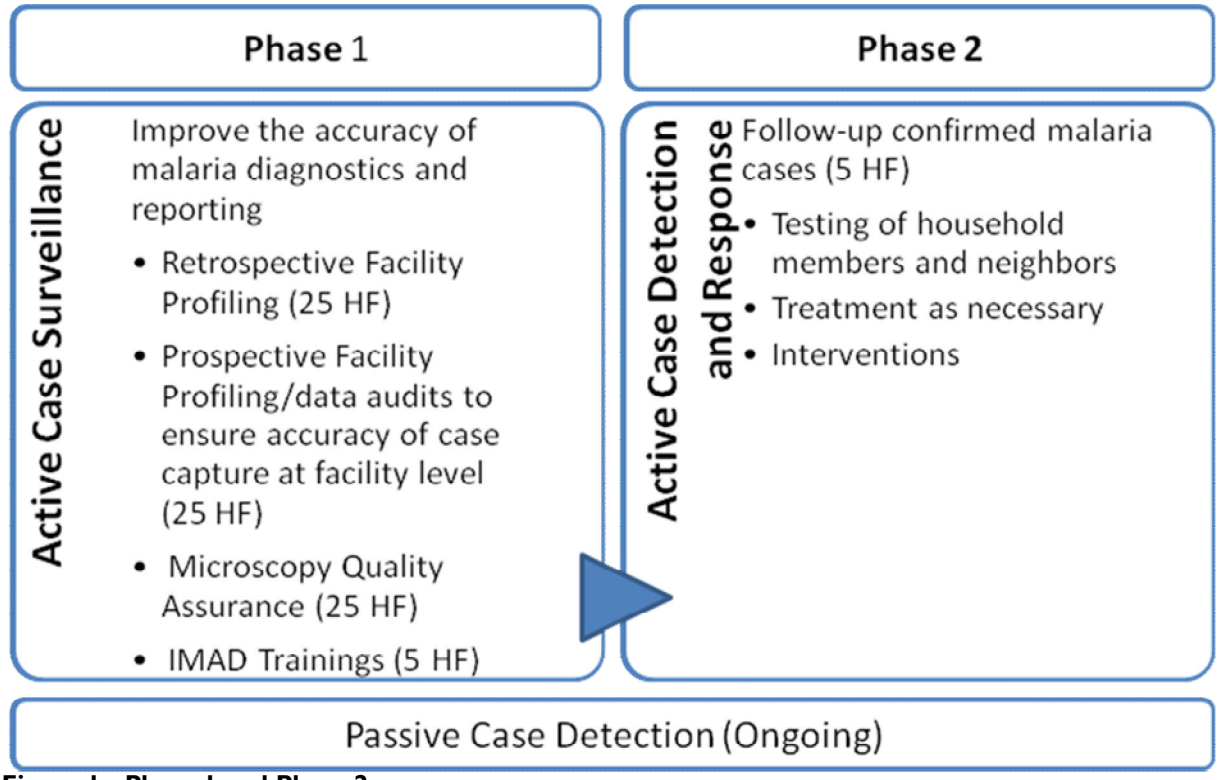

Figure 1 - Phase 1 and Phase 2
The pilot project will occur in two phases. Phase 1 will lay the groundwork for success of Phase 2, the active case detection and response system.

2.1 Literature Review

Although very limited information exists that reviews a combined ACS and ACD surveillance system, a substantial body of literature exists describing how ACD strategies were employed via mass blood surveys to detect and treat asymptomatic malaria in order to control, and in some instances, eliminate malaria. Historically, an ACD strategy was first suggested in 1960 by Perez Yekutiel, an Israeli epidemiologist [13]. Eastern Taiwan initiated a mass blood survey in 1958 as part of a malaria eradication program to find and eliminate the last remaining foci of autochthonous malaria following DDT (Dichloro-Diphenyl-Trichloroethane) spraying [14]. Mass blood surveys for ACD have also been used in India, the Philippines, Venezuela and Oman [6, 15-18]. ACD has been used as the primary malaria control strategy in southern China with good success. These instances of ACD have been very successful, but have been implemented under specific conditions – such as relatively resource-rich environments, implementation on an island with limited population movement and/or significant reduction in incidence via use of DDT, or rural rather than urban settings like Lusaka District [6]. A combined ACS-ACD system is currently being tested in a rural region of Southern Zambia, following a project which identified local health system personnel as a resource in facilitating ACD [19]. The work in progress uses active case surveillance to review health clinic registers in order to assist in the detection of outbreaks of malaria and target interventions to foci where parasite reservoirs are likely to exist. Once a malaria case is confirmed at the clinic level, an ACD response is initiated [20]. This type of combined active surveillance system with ACD response, however, has not been implemented in an urban area like Lusaka District.

3. Rationale

Currently, the Government of Zambia's national malaria surveillance strategy is PCD, where cases are detected only when a patient seeks care for the symptoms of malaria. PCD, however, does not ensure either the detection of all actual malaria cases or the detection of asymptomatic carriers of malaria in a population, because in the absence of symptoms individuals generally do not seek treatment for their infection. A large proportion of *Plasmodium falciparum* infections in malaria endemic countries are asymptomatic or sub-clinical [6]. In some malaria-endemic areas, microscopy-confirmed levels of asymptomatic carriers have been reported as high as 39% [6]. These asymptomatic carriers act as a reservoir of parasites that invariably are essential for maintaining the cycle of malaria infection and increase the probability of malaria transmission if mosquito vectors are present. If only symptomatic individuals who present at health facilities are tested and treated for malaria, asymptomatic carriers will continue to go undetected, providing a parasite reservoir which enables continual malaria transmission [7-9]. ACD will target these asymptomatic carriers through household-level testing and treatment in order to reduce parasite reservoirs and decrease the probability of continued malaria transmission. The implementation of an active surveillance system with ACD response is relevant to the objectives of the Zambia National Malaria Control Program, the President's Malaria Initiative (PMI) Malaria Operational Plan and the general epidemiological status of malaria in Lusaka District on several levels. First, the epidemiological situation in Lusaka is similar in many facets to a "pre-elimination" stage where parasitemia prevalence is low [1, 2]. Lusaka District continues to use universal IRS coverage as a preventive measure; however a targeted, focal approach may be more suitable at this stage considering the associated cost and insecticide resistance concerns. Additionally, RDTs are widely available and provide a feasible platform for the diagnosis and treatment of asymptomatic carriers within the community [11, 12].

4. Objectives

This proposal presents an integrated approach to enhance malaria surveillance within Lusaka District. The aim of Phase 1 is to increase the accuracy of malaria diagnostics and reporting at all 25 Lusaka District health facilities. Phase 2 will focus in on 5 Lusaka district health facilities to pilot ACD and response activities. Specific objectives include:
Phase 1

1. Strengthen malaria diagnostic capacity through Improving Malaria Diagnostics Project (IMaD) trainings and microscopy quality assurance activities.
2. Collect retrospective malaria case data from all health facilities to develop a 'facility profile' for each health clinic.
3. Prospective data from patient and laboratory registers will be collected weekly at the 5 pilot health facilities and compared to Health Management Information System (HMIS) data to ensure that all malaria cases are accurately reported. This data audit is the active case surveillance activity.

Phase 2

1. Within 5 pilot health facilities, enhance the malaria surveillance system by adding to the active surveillance an ACD component, in which asymptomatic carriers are identified and treated.
2. Begin a targeted intervention response that uses active surveillance and ACD data to inform the timely allocation of intervention resources [IRS or Insecticide-Treated Mosquito Nets (ITNs) depending upon availability].

3. Identify the effectiveness of active surveillance-ACD by comparing the number of confirmed malaria cases and accuracy of data reporting prior to and during the pilot project at each participating health facility.

5. Phase 1 Implementation

The active surveillance system with ACD response will be implemented by the MOH/NMCC, Lusaka District Health Management Team (DHMT) and participating health facilities in collaboration with key stakeholders, including Malaria Control and Evaluation Partnership in Africa (MACEPA), IMaD, ZISSP and Akros. The implementation will occur in a two-phase approach. Phase 1 will focus on the training of clinic and laboratory staff at each health facility regarding the proper use of malaria case definitions (suspect versus confirmed malaria case), malaria diagnostic procedures and case management. Microscopy quality assurance, accurate reporting and audits of malaria case data will also receive attention during Phase 1. Data reported in HMIS each month will be verified by on-site review of patient and laboratory registries to ensure that all cases are reported. All of these steps are necessary to ensure that all malaria cases reported from each health facility are true positives which have been confirmed via microscopy or RDT diagnosis. The success of Phase 2 (ACD) is dependent on consistent reporting of malaria data with minimal false positives being reported from health facilities to enable efficient case follow up.

5.1 Roll-Out Meeting

A roll-out meeting for all 25 Lusaka District health facilities will be hosted by the NMCC in early January for the Active Case Surveillance/ Detection and Quality Assurance activities of the rest of the year. Delegates from each health facility will include the in-charge, a clinician, a representative from the laboratory, and a data management specialist. The roll-out meeting will serve three purposes:

1) To provide a brief background of malaria case data from Lusaka District illustrating the need for more accurate diagnostics and malaria data reporting from all health facilities.
2) To bring key health facility personnel together to discuss the use of the standardized MOH malaria case definition and case management procedures for all patients, the correct data reporting procedure for both clinicians and laboratory personnel, and negative effects of improper use of case definitions, non-standard case management, and improper data reporting.
3) To introduce and explain the purpose and coordination of the combined efforts of all Phase 1 activities to be conducted in all 25 Lusaka District health facilities beginning November 2010. A short description of how these Phase 1 activities support and provide the groundwork for Phase 2 (ACD and response) will also be provided.

5.2 Retrospective and Prospective Facility Profiling

In Zambia, old IMCI treatment guidelines emphasized treatment of fever as malaria and therefore health workers still treat clinical malaria cases among febrile children under age five with antimalarials. However, current guidelines encourage use of diagnostic tests to confirm suspected malaria cases. Diagnostic testing is more likely to occur in urban centers where malaria is less prevalent and where availability of laboratory services is good. Diagnostic confirmation is now recommended prior to antimalarial treatment for all patients; although high numbers of suspect or clinical malaria cases continue to receive antimalarial treatment.

The purpose of the health facility profiling activity will be to develop a data portfolio from 2004 forward for all 25 health facilities in Lusaka District. The profiling activity will provide baseline data of suspected and confirmed malaria cases (microscopy and RDT) and these data may be shared with health facility personnel during follow-up trainings to promote diagnostic confirmation prior to antimalarial prescription. These data will further provide a longitudinal trend in malaria cases for each health facility to determine the effect of implementing upcoming activities on malaria burden within the district. It is expected at the outset that implementing focused trainings to standardize malaria case definitions and implementing microscopy quality assurance and diagnostic trainings will alter the frequency of malaria case reporting at facility level. It is important to establish a true baseline for malaria cases prior to implementing community-based malaria case follow ups.

This profile will be created by reviewing Health Impact Assessment (HIA) 1, Out-Patient Department (OPD), In-Patient Department (IPD) and laboratory registers at each clinic to document the number of total consultations, confirmed malaria cases and method of diagnosis. The purpose of the audit is to assure that the HMIS reports have captured 100% of suspect and confirmed malaria cases; hence HIA1 forms will need to be confirmed with coordinating tally sheets and registers. Specifically, the data elements that will be collected include (in order of columns on the Retrospective Profiling Data Collection Form, see Appendix A):

- Column 0 – Number of total consultations collected from the HMIS monthly reporting form (HIA1).
- Column 1 - HMIS malaria cases. These data will be collected from the disease aggregation form (HIA1) and figures will be confirmed with coordinating tally sheets and original OPD/IPD registers.
- Column 2a/2b – Number of persons tested with RDTs; number of persons tested by microscopy. These data will be collected from laboratory registers separately for microscopy and RDTs.
- Column 3a/3b – Number of persons with positive RDT results; number of persons with positive microscopy results. These data will be collected from laboratory registers separately for microscopy and RDTs.
- Column 4 – Amount of Coartem available. As a proxy for the number of people treated with Coartem. These data will be gathered from stock management forms distributed by NMCC or from facility stock management cards. Data will be disaggregated by Coartem pack quantity (6 packs, 12 packs, 18 packs, 24 packs).

Logistically, it will take approximately 16 weeks for collection of retrospective data (2004 forwards) from HIA1, laboratory registers, RDT registers and supply vouchers/stock control cards from all 25 Lusaka health facilities. Six teams of 2 people each will be responsible for entering the specified data into the data collection sheets. These teams will be tallying paper-based register into data collection forms (Appendix A) while sitting at the health facilities (versus collecting photo images of the data for entering into electronic records at a later date). Clarification on register data will be sought from facility staff as needed. The 6 teams will be managed by two supervisors; one of those supervisors will be Mr. Zunda Chisha, ACS Program Manager. The role of the supervisors will be to ensure the data are collected efficiently and accurately over the time period. The teams will prioritize the 5 pilot health facilities in order to complete the profiling in these facilities quickly and transition to preparation for ACD response.

Once all retrospective data are captured, prospective data capture will ensue. The same data elements will be captured from all 25 health facilities during the prospective activities. The 5 pilot facilities will have weekly data reviews checking for data accuracy and completeness. During these reviews, the data

elements (Appendix A) will also be collected from the facilities. The remaining 20 facilities will also be reviewed/audited and data collected but on a monthly basis due to resource constraints. During prospective data collection, the program manager will monitor clinical and confirmed case numbers and completeness of reporting. Small-scale informal trainings will be conducted at the health facilities to ensure clinicians and facility personnel confirm malaria diagnoses with microscopy or RDTs, that the data are recorded correctly, and to understand the provision of antimalarial treatments for suspected malaria patients not otherwise receiving a parasitological confirmatory test. Furthermore, retrospective and prospective comparisons between HMIS data and facility record books will be made in order to identify whether HMIS is sufficiently capturing facility-recorded data. If discrepancies are found, efforts will be made to identify the source of the differences and to address issues contributing to the differing data.

5.3 Microscopy Quality Assurance

Microscopy quality assurance (QA) will be conducted in all 25 health facilities beginning November 2010 and will continue for one year. The objective of the microscopy QA is to make certain health facility laboratory personnel are providing accurate microscopy results. In an effort to collect retrospective microscopy data, during November 2010, laboratory registers (January 2010 to present) from all 25 health facilities will be imaged and malaria blood slides, including all facility identified malaria slide positive patients and a small fraction of facility identified malaria slide negative patients, will be collected for re-reading by NMCC and Lusaka District Health Office (DHO) microscopists. From November 2010 and forward, microscopy QA activities will happen on a monthly basis. During this prospective QA work, laboratory registers will be imaged for the month around which slides are being collected so that it will be possible to match patients (by their OPD and laboratory register IDs). The blood slides will be collected from health facility laboratories each month during the facility data collection team visits and delivered to the NMCC laboratory for QA. Data collected through the microscopy QA will include (in order of columns on the Summary Data on Slide Microscopy Quality Assurance, see Appendix B):

- Column 5 - Number of positive slides pooled for quality assurance. This is the number of slides received from the health facility for facility-reported positives.
- Column 6 - QA results: facility positive slides. These figures are the summary results of quality assurance readings for facility-positive results.
- Column 7 – Number of negative slides pooled for quality assurance. This is the number of slides received from the health facility for facility-reported negatives.
- Column 8 – QA results: facility negative slides. These figures are the summary results of quality assurance readings for facility-negative results.

5.4 IMaD Trainings

To ensure intervention teams do not waste resources initiating an ACD response following a false positive diagnosis, it will be necessary to make certain that diagnostic procedures at each participating health facility are accurate and precise and practices are consistent with MOH/NMCC protocol and between health facilities. The microscopy QA efforts will be instrumental in standardizing microscopy practices. Within five health facilities in Lusaka District, specific trainings will also be provided through NMCC with the support of IMaD to ensure consistent microscopy practices and quality control measures are followed by all laboratory personnel. Specifically, NMCC and IMaD will initiate their Outreach Training and Support Supervision (OTSS) protocol in the 5 pilot ACD health facilities [23]. This protocol initially surveys laboratory facilities to assess their readiness and ability to provide quality microscopy services for malaria diagnosis, provides quality training to laboratory personnel on

microscopy techniques, and offers follow-up scoring and quality assurance of microscopy services. In these 5 pilot health facilities, the quality assurance activities will be in coordination with NMCC QA activities to reinforce better reading and reporting of malaria microscopy results and to minimize discrepancies among slide readers. NMCC and IMaD coordinators will also observe health facility personnel practices when using rapid diagnostic kits to ensure that accurate diagnostics will continue even during weekends or evenings when laboratory facilities are closed. Small group trainings will be conducted (<5 participants) as deemed necessary to ensure consistent follow through of the NMCC and MOH protocols. Health facility personnel trainings will also include a general background on the importance of quality malaria diagnostic data for this project, as well as for ongoing surveillance concerns. Health facility personnel will be provided a 'refresher' training every 4 months. Quality control activities conducted through NMCC and IMaD will be ongoing in the five pilot health facilities. The IMaD activities will be limited to the five pilot health facilities due to resource constraints.

		2010		2011													
	Activity	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Key Personnel**	**Notes**
Phase 1	Roll-out Meeting															NMCC, DHMT, MACEPA, IMAD, PMI,	Nov 23 proposed date. Meeting is intended for representatives of all 25 health facilities. All surveillance activities within Lusaka District will be shared including the purpose of all activities.
	Slide Checking/QA															MACEPA, Moonga Hawela, Jacob Chirwa	Ongoing throughout all 25 Lusaka District health facilities.
	IMAD trainings			Ongoing sampling of slides for QA - feedback/training with lab												IMAD, Timothy Nzangwa	In 5 pilot health facilities. Awaiting budget approval. Approximate time for initial trainings 1 day per health facility. Ongoing trainings within health facilities throughout 2011.
	Facility Profiling	Retrospective Data (prioritize the 5 pilot health facilities)					Prospective Data/Active Case Surveillance									Akros, Zunda Chisha	Retrospective data collection to take ~14-16 weeks. Prospective data collection monthly in 20 facilities and weekly in the 5 pilot health facilities.
Phase 2	Active Case Detection and Follow-up						Start date tentative and depending on quality of confirmed malaria case data from each pilot health facility.									Akros, Zunda Chisha	Active case detection and follow-up will commence only once the confirmed malaria case data coming from the 5 health facilities is considered accurate and reliable. Phase 2 (ACD) will only be successful if objectives in Phase 1 are fully achieved.

Figure 2 - A timeline for Phase 1 and Phase 2 activities
Phase 1 activities will be conducted by NMCC, DHMT, health facility staff and multiple partner agencies. Phase 2 activities will commence once the confirmed malaria case data coming from the 5 pilot health facilities is considered accurate and reliable.

6. Phase 2 Implementation

Phase 2, the active case detection and response activities, will commence once confirmed malaria case reports from each facility are considered accurate and reliable. In phase 2, an intervention team will visit the households of individuals who have been diagnosed with RDT or microscopy confirmed malaria at the participating health facilities. Family members and neighbors of the index case will be tested for malaria parasites with RDTs and treated with antimalarials as necessary. Based upon results of the ACD response, malaria interventions will be targeted to households and surrounding areas where risk of transmission has been demonstrated.

6.1 Selection of Pilot Health Facilities

Five health facility catchment areas have been chosen for Phase 2 implementation. The choice of these health facilities was based on the following criteria, established by the DHMT with NMCC support:

- Population of selected health facility catchment areas are within 2nd and 3rd quartiles (compared to all Lusaka District health catchment areas).
- Availability of laboratory facilities within the clinics which offer sufficient diagnostic capacity to accurately detect malaria via microscopy.
- Health facilities with "manageable" caseloads.
- Sufficient clinic staffing.
- Data management practices at health facilities are classified by the DHMT as "average to good."
- Facilities whose catchment areas were known by the DHMT to actively participate and be receptive to health activities versus being "hostile communities."
- Known malaria incidence rate for each health facility catchment area by month (HMIS 2009 data).
- Positive clinician/laboratory relationship.

A map of the health facility catchment areas of the five selected pilot facilities is found in Appendix C.

Table1. The 5 selected pilot health facilities and the selection criterion established by the Lusaka DHMT.

Health Facility	Lab - # staff	Data Management	Community	Clinic Staffing	Caseload (2009 HMIS - DHMT)		Population
					Clinical	Confirmed	
Chainda	No lab	Good	Receptive	Sufficient	3343	3	41618
Chelstone	3	Good	Receptive	Sufficient	3968	43	86376
Chilenje	3	Very Good	Receptive	Sufficient	7383	1873	91773
Matero Ref	2	Good	Receptive	Sufficient	10145	1123	98529
Mtendere	4	Good	Receptive	Sufficient	5766	412	68277

6.2 Phase 2 Workflow

This section describes the proposed ACD workflow specific to the five pilot health facilities and details the actions to be taken when patients are first received into the health facility to the activation of an appropriate intervention response. Note, the numbered items coordinate with Appendix D.

1. Health facility diagnosis and malaria treatment - PCD. The current malaria surveillance system depends upon passive case detection, which is ongoing at all Lusaka District health facilities. In the five pilot ACD facilities, febrile patients who exhibit malaria symptoms will continue to be received at all selected health facilities via PCD. As these individuals are received, health facility personnel will collect blood smears to be read for malaria parasites by the health facility laboratory. If the patient is at the facility and needs to be tested during weekends or at night when the laboratory is likely to be closed, a rapid diagnostic test (RDT; ICT®; IC Diagnostics, Cape Town) will be used for diagnosis. The diagnostic protocol will be based on instructions from the NMCC and the MOH which require clinic personnel to test only attendees that are febrile and exhibit signs of malaria. RDT cassettes and blood slides will be saved for validation and quality control (see Phase 1 – Microscopy QA). All persons with confirmed malaria diagnosis will be treated with artemether/lumefantrine unless it is contraindicated [24, 25]. The dosage for all individuals, including pregnant women and children under five, will be in accordance with current MOH guidelines.

2. Data reporting – PCD triggers ACD within the surveillance system. At the clinic level, confirmed malaria patient data will continue to be recorded within the health facility register according to the current NMCC PCD system (DHIS 1.4). Health facility personnel will ask confirmed malaria patients to identify their location of residence within the health facility catchment area. Their residence will be marked on a wall map of the health facility catchment area, developed specifically for this project. The wall maps will include roads and landmarks to assist in orientation. Information collected must be sufficient for navigation to the patient's location of residence. Health facility personnel will be trained prior to the initiation of Phase 2 in methods to assist patients in identifying their location of residence. Appendix E indicates the specific data that will be collected from each patient to include the patient's name, age, malaria diagnostic information, the home address (if available), the location of residence as identified by the wall map (neighborhood/compound and nearest cross-streets) and driving directions to the location of residence. Clinic staff will inform the confirmed malaria patient of the upcoming epidemiological follow-up investigation that will take place at their household.

Intervention Team Members

Members of each intervention team will originate from the health facility/catchment area in which they operate and respond to malaria cases within that facility catchment area. Team members will be more familiar with their catchment areas, facilitating the navigation and coordination of the response activities. Team members will be as follows:

1) **Environmental Health Technician (EHT)** based at the clinic. EHTs are trained to provide entomology and IRS support and could assist the team with these activities as needed. This individual would ultimately be responsible for coordinating and managing the team activities while in the field.
2) **Community Health Worker (CHW)**. CHWs would conduct RDTs during the intervention response and provide IEC materials. MOH policy currently prohibits CHWs from providing antimalarials, so a nurse or EHT would be responsible for providing antimalarials if RDT + results are found during the intervention.
3) **Registered nurse** (preferably a public health nurse if available). An RN based at the clinic would join the team for clinical support and to provide antimalarials if RDT+ results are found. The RNs would assist the CHWs to test community members during the intervention.
4) **Spray operators.** During IRS activities in Lusaka District, trained volunteer spray operators are recruited to provide spray services to targeted households. EHTs have a list of volunteers available as needed to provide IRS support.

Note: The US government cannot provide salary top-ups or incentives to government employees. Therefore, all intervention activities will be required to be completed within the normal working hours of government staff. Volunteers (CHWs and spray operators) will be provided meal and transport allowances based on the Lusaka DHMT-rate.

3. **Notification.** At the five pilot health facilities, when malaria cases are confirmed, the active case surveillance project manager and district-level staff will be notified – at first, through facility visits or phone calls, and eventually via weekly Short Messaging Service (SMS) data transfer. The intervention team, which will be based at the health facility, will likely activate once per week to follow-up any confirmed malaria cases detected during the week. The intervention team leader will review the individual patient form, including the RDT cassette and/or bloodslide used to confirm the diagnosis. If the location of residence of the confirmed malaria patient is outside of the health facility catchment area, or if the patient reports travel history within three weeks, this information will be noted on the individual patient form, however an intervention response will typically not be initiated.

4. **ACD activation.** The intervention team leader will receive a copy of the individual patient data and will progress immediately along with intervention team members to the location of residence of the confirmed malaria patient. ***Note:*** *If the workload exceeds the resources of the intervention team, the program manager may be required to conduct the ACD only at a sampling of the passively detected cases. The sampling criteria will be determined from the current epidemiological status and the location of recent malaria case reports.*

5. Contact survey. Once at the household, the ACD protocol will be explained to household residents. Information, Education and Communication (IEC) materials specific to ACD and in development with NMCC and MACEPA will be provided to household residents to assist in the explanation of the protocol and purpose. The intervention team will begin their work at the household of the index case. A contact survey (see Appendix F) will be used to identify all usual members of the index case household. Basic characteristics of each person will be collected including their age, relationship to the head of the household, travel history, history of malaria diagnosis, current malaria diagnosis, and antimalarial treatment information. Once the malaria parasite testing is complete at the index house (see #6 below) and contact survey data has been collected, the intervention team will move to the nearest neighboring household within 50 meters. The contact survey and malaria testing will be completed within that household. The intervention team will continue to visit all households approximated to be located within a 50-meter radius from the index household. The intervention team will be encouraged to work systematically (in a clockwise pattern) from household to household within the 50-meter radius. GPS coordinates will be recorded for each household and included on the contact survey form. For purposes of the household listing and to facilitate data entry at the time of the contact survey, household names will be recorded on the survey form. Each individual will be assigned a unique identification code at the time of database entry. The names of respondents will be kept as strictly confidential information and will not be used in the presentation of results or associated with the results in any way or be available to anyone except the project manager, project director and health center staff. Subjects will be assured that their identity will not be disclosed.

6. Malaria parasite testing. The NMCC-approved Information Communication Technology (ICT) Malaria Pf RDT will be used for parasite testing during ACD [11]. RDT testing will be performed according to manufacturer instructions. The individual administering RDTs on the team will receive standardized training in finger-prick protocol for rapid diagnostic testing. Every effort will be made to prevent secondary infection from the finger prick by using sterile lancets for each individual and by cleaning the finger with an alcohol swab prior to the finger-prick. Ample latex gloves will be supplied to ensure glove change prior to conducting the RDT on each individual.

7. Antimalarial treatment. Individuals with a positive RDT and clinically not fitting into the severe malaria classification (including severe anemia, prostration, impaired consciousness, respiratory distress, convulsions, circulatory collapse, abnormal bleeding, jaundice and passing black/brown [dark] urine) will

receive immediate malaria treatment according to Zambia national malaria treatment guidelines. Current guidelines recommend artemisinin-containing combination antimalarial treatment (currently Coartem®). Any individuals clinically assessed to have severe malaria will be transported immediately to the nearby health facility. Additionally, individuals with a positive RDT and already treated with Coartem® within the past two weeks will be referred to the nearest health facility for additional evaluation.

6.3 Interventions

Intervention response activities aside from prescription of antimalarials could involve IRS or ITN distribution, depending upon available resources. Any IRS or ITN activities will follow the completion of the contact survey and RDT testing at the households. Focalized spray services will be provided to households of RDT-confirmed malaria patients following guidelines found in the MOH protocol. Additionally, intervention team members will be provided MOH standardized IRS training. If households had been sprayed during the current IRS season, these structures would not be sprayed again as part of the intervention response activities, given resource constraints. Universal IRS coverage has been ongoing in Lusaka District, thus residents will most likely be familiar with standard IRS practices. The intervention team will coordinate with ongoing IRS activities and data-recording protocol conducted by the MOH NMCC. Community health workers previously trained in IRS protocol may be hired to assist with IRS activities. Datasheets currently in use by IRS teams in Zambia ("Spray Operator Daily Record – District IRS Programme") will be used to record IRS and/or ITN information. Household and structure IDs will also be recorded on the contact survey forms. If necessary, the Active Case Surveillance program manager will alert entomologists at the NMCP and/or DHO for an entomological investigation subsequent to the contact survey and intervention. IEC materials covering general malaria information and IRS-readiness for households which are already developed and approved by the MOH will be distributed to the participating households along with ACD materials.

6.4 Monitoring and Evaluation

The enhanced surveillance system proposed here will serve to answer a number of questions regarding the effectiveness of an active surveillance system with ACD response in an urban environment. The system will be monitored using indicators listed in Table 2.0. Included in those indicators are the resources necessary to conduct the pilot project at all phases (active surveillance, ACD, intervention) including the necessary personnel and commodities. This will include the number and qualifications of required human resources. The pilot surveillance project will provide information as to whether the enhanced surveillance system combined with targeted interventions will require more or less resources to achieve comparable levels of reduction in incidence as universal IRS application in a highly dense urban environment. We will monitor the malaria incidence reported at the pilot health facilities to identify whether the active detection and treatment of asymptomatic malaria cases does also lead to a decrease in symptomatic, passively detected malaria cases (Table 2.0). Malaria case data collected using active surveillance/record audits during the pilot project will be compared to malaria case data as reported through the customary HMIS channels. Furthermore, mapping and GIS analysis will be carried out in order to better understand the distribution of asymptomatic cases in relation to symptomatic cases. In general, our hope is that the enhanced surveillance system will achieve sustained reduction in symptomatic (as well as asymptomatic) malaria cases to such a level that scale-up to additional health facility catchment areas is supported.

Table 2 M&E Indicators. Below is a list of the indicators to be collected and monitored throughout the study. Note that all malaria case numbers detected by passive and active surveillance in the health centers will be kept separate from cases actively detected in the field, as these data are collected using different criteria.

Indicator	Notes
Resources required	Monthly sum of resources required to conduct the pilot system. This indicator will be used to compare costs for the PCD-ACD versus universal IRS campaigns covering the same area. The resources required at all stages of the pilot will be monitored including the diagnostic training, active surveillance (where records are audited at health facilities), PCD-ACD and interventions applied.
PCD: Total tested Total positive Total treated	A trend line will be developed for each health facility to track from 2009 forward the total number of individuals tested for malaria, those identified as positive, and those treated. Once the IMaD trainings begin, we expect greater specificity in the diagnoses, meaning the total number of positive diagnoses will likely drop as the project progresses. These figures will be disaggregated by diagnostic method if possible. The difference between passively detected cases and those detected by weekly health center audits will be documented.
Passive Case Detection (Malaria incidence)	Case counts (total positive from above) from health facilities will be the numerator used to calculate the malaria incidence rate per week for passively detected cases. The denominator will be a numerical estimate of the population served within the health facility catchment area from the 2001 census. The population figure is adjusted annually for normal population increase.
ACD Response	Number of times response team mobilized per month. This figure will also be compared to the number of PCD cases qualifying for ACD response in order to identify the percent of cases the intervention team was able to respond to. The ACD response indicator will also be disaggregated by intervention type (testing and treatment only, testing and treatment plus IRS, or testing and treatment plus ITNs).
Active Case Detection: Total tested (RDTs) Total positive (RDTs) Total treated	The active case detection figures include the household-based RDT and treatment data collected during the ACD response activity. These figures may also be calculated as a rate with the number of positive RDTs as the numerator and the total number tested as the denominator.

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8. Appendixes

8.1 Appendix A - Facility Profiling Data Collection Form

Survey date (dd/mm/yy)	
Name Province	
Name District	
Name health facility	
Urban health clinic	
Year	
Compiled by (name):	

	0		1		2a		2b		3a		3b		4			
Indicators	Number of total consultations		HMIS Malaria cases		Number of persons tested with RDTs		Number of persons tested by microscopy		Number of persons with positive RDT results		Number of persons with positive microscopy results		Amount of Coartem® available			
Month	<5 years	≥5 years	<5 years	≥5 years	<5 years	≥5 years	<5 years	≥5 years	<5 years	≥5 years	<5 years	≥5 years	6 packs	12 packs	18 packs	24 packs
January																
February																
March																
April																
May																
June																
July																
August																
September																
October																
November																
December																
Total																

8.2 Appendix B - Summary Data on Slide Microscopy Quality Assurance

Summary data on slide microscopy quality assurance

Collection date (dd/mm/yy)

Name Province

Name District

Name health facility

Year

Collected by (name):

	0		1		2a		2b		3a		3b		5		6				7		8			
	Number of total consultations		HMIS Malaria cases		Number of persons tested with RDTs		Number of persons tested by microscopy		Number of persons with positive RDT results		Number of persons with positive microscopy		Number of Positive slides pooled for Quality		QA results: **Facility positive** slides				Number of Negative slides pooled for Quality		QA results: **Facility negative** slides			
Month	<5 years	≥5 years	<5 years	≥5 years	<5 years	≥5 years	<5 years	≥5 years	<5 years	≥5 years	<5 years	≥5 years	<5 years	≥5 years	<5 years: C	<5 years: C	≥5 years: C	≥5 years: C	<5 years	≥5 years	<5 years: C	<5 years: C	≥5 years: C	≥5 years: C
Jan																								
Feb																								
March																								
April																								
May																								
June																								
July																								
Aug																								
Sep																								
Oct																								
Nov																								
Dec																								
Total																								

Notes

Column 0-11: Write NA if data is missing

Column 0-6: If data is not available by age-group: Give the total number and write below the column that age-group aggregated data was not available

0) Collected from HMIS monthly reporting form (HIA1)

1) Collect data from Disease Aggregation Form HIA1 (confirm figures with tally sheet). If data is missing from HIA1 for 1 or more months, collect the data from the OPD/IPD register. This is a sum of confirmed plus clinical cases.

2a or b) Collect data from Laboratory or lab/RDT register, separately for microscopy and RDTs (confirm figures with the Disease Notification Document, ND3). Write "NA" if no data is available (e.g. register is missing or nothing is recorded in the register.

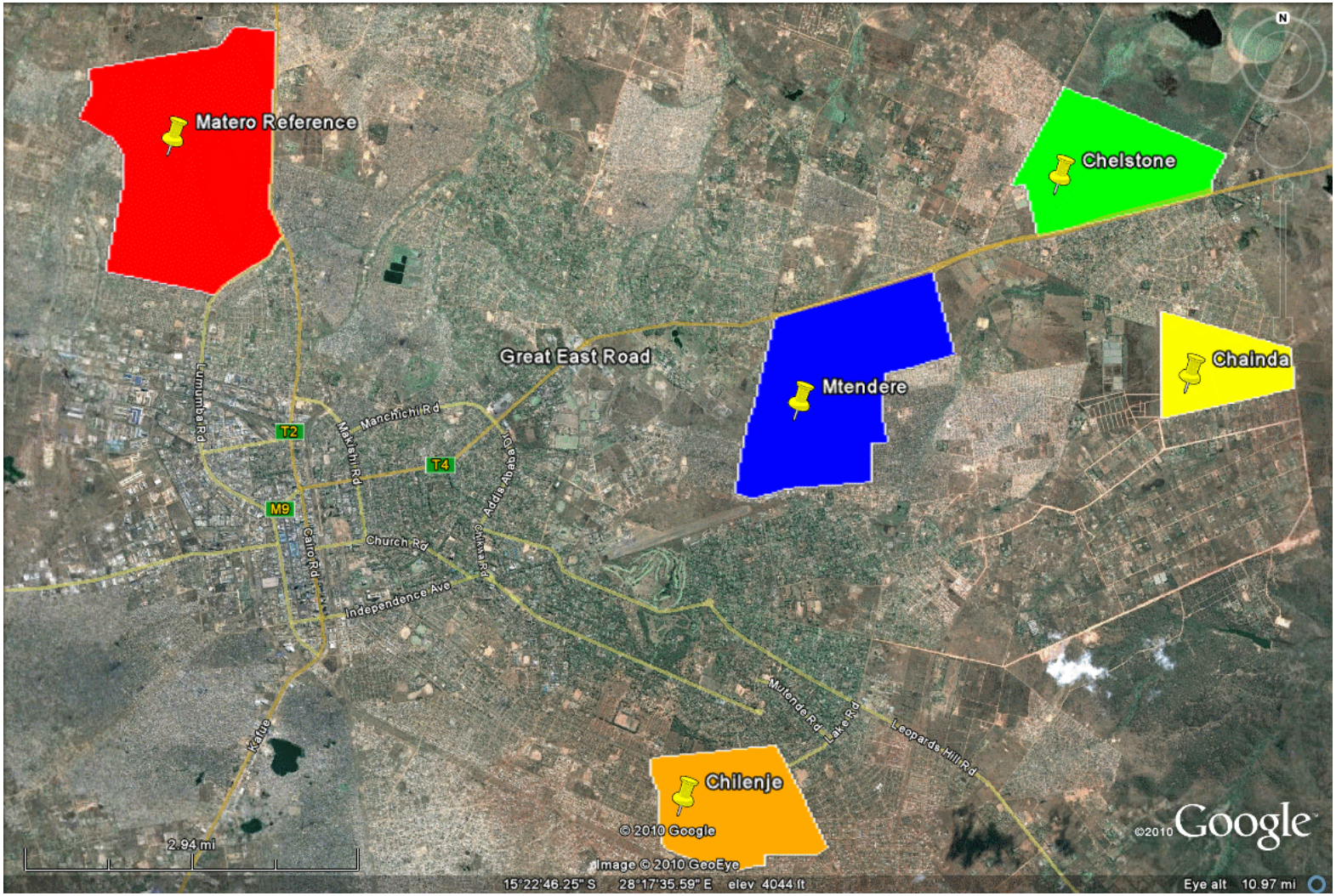
3a or b) Collect data from the Laboratory or lab/RDT register, separately for microscopy and RDTs (confirm figures with the Disease Notification Document, ND3). Write "NA" if no data is available (e.g. register is missing or nothing is recorded in the reg

4)

5 and 7) Record number of slides received from the facility by facility-reported positive or negative. For positives where all positives have been saved, this should be equal to 3b.

6 and 8) Record summary results of QA readings by negative and positive facility results.

8.3 Appendix C – Health Facility Catchment Areas of the 5 Selected Pilot Facilities

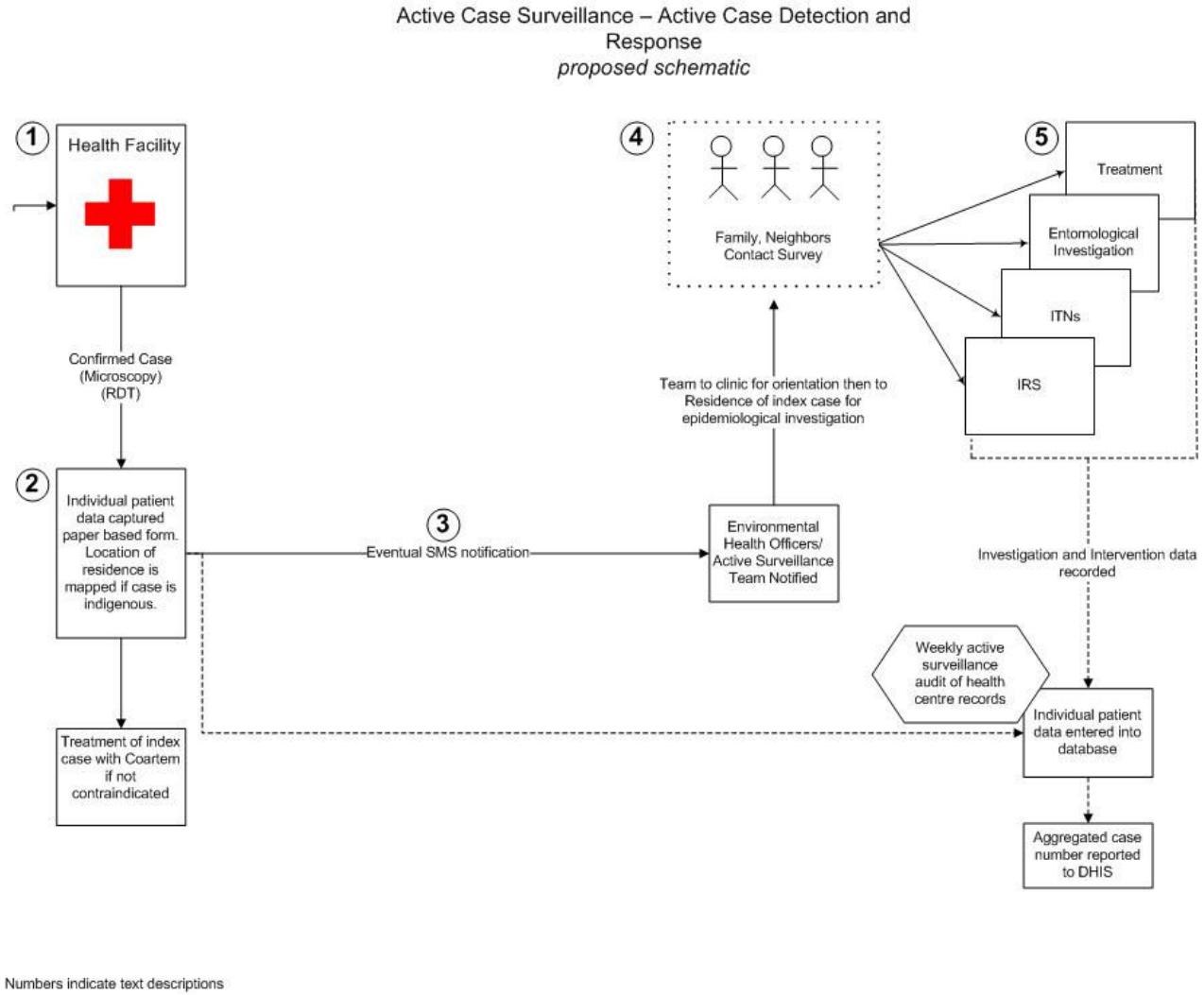


		2010		2011													
	Activity	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Key Personnel**	**Notes**
Phase 1	Roll-out Meeting															NMCC, DHMT, MACEPA, IMAD, PMI,	Nov 23 proposed date. Meeting is intended for representatives of all 25 health facilities. All surveillance activities within Lusaka District will be shared including the purpose of all activities.
	Slide Checking/QA															MACEPA, Moonga Hawela, Jacob Chirwa	Ongoing throughout all 25 Lusaka District health facilities.
	IMAD trainings			Ongoing sampling of slides for QA - feedback/training with lab												IMAD, Timothy Nzangwa	In 5 pilot health facilities. Awaiting budget approval. Approximate time for initial trainings 1 day per health facility. Ongoing trainings within health facilities throughout 2011.
	Facility Profiling	Retrospective Data (prioritize the 5 pilot health facilities)					Prospective Data/Active Case Surveillance									Akros, Zunda Chisha	Retrospective data collection to take ~14-16 weeks. Prospective data collection monthly in 20 facilities and weekly in the 5 pilot health facilities.
Phase 2	Active Case Detection and Follow-up						Start date tentative and depending on quality of confirmed malaria case data from each pilot health facility.									Akros, Zunda Chisha	Active case detection and follow-up will commence only once the confirmed malaria case data coming from the 5 health facilities is considered accurate and reliable. Phase 2 (ACD) will only be successful if objectives in Phase 1 are fully achieved.

Figure 3 - A timeline for Phase 1 and Phase 2 activities

Phase 1 activities will be conducted by NMCC, DHMT, health facility staff and multiple partner agencies. Phase 2 activities will commence once the confirmed malaria case data coming from the 5 pilot health facilities is considered accurate and reliable.

8.4 Appendix D – Active Case Detection and Response – Proposed Schematic



8.5 Appendix E – Passive or Actively Detected Cases in Health Centers

Although this specific form will not be used, the data within must be gathered at the health facilities. The project will attempt to use current collection procedures to collect the data.

Patient Name	
First Name	
Surname	

Passive Malaria Case Detection Form					
Patient ID				Health Facility	
Date					
Age		Sex	M F		

Diagnostics			
Microscopy		**Rapid Diagnostic Test (RDT)**	
Slide taken by		Performed by	
Microscopist		Result	
Parasite density		RDT Label	
Gametocytes present (Y/N)	YES NO		
Microscopy Result			
Performed by			
Slide label			

Initiate investigation (+RDT and +Microscopy): YES NO

If YES, please continue below

Travel History
Did the patient travel overnight away from home since the onset of the current clinical episode? YES NO *If NO, please continue below*

Previous Malaria Case Instance			
Date		Symptoms	
Diagnosis(method and outcome)		Antimalarial treatment	

Patient Household Location and Contact Information			
Street Address		Neighborhood	
City/Town/Village		Telephone Number	
Map Location (use health facility wall map)			
Other Information to assist intervention team to locate house.			
GPS Coordinates at household	Latitude:	Longitude:	

8.6 Appendix F – Actively Detected Cases in the Community – Contact Survey

Patient Name	
First Name	
Surname	

Active Malaria Case Detection Form					
Patient ID				Health Facility Catchment Area	
Date					
Age		Sex	M F		
Specific malaria symptoms? please list				Index case structure? (does passively detected case reside here)	YES NO
Rapid Diagnostic Test (RDT)				**Travel History**	
Performed by				Did the patient travel overnight away from home since the onset of the current malaria case instance? YES NO	
Result (if positive, continue survey)				Travel Notes:	
RDT Label					
Previous Malaria Case Instance					
Date				Symptoms	
Diagnosis (method and outcome)				Antimalarial treatment	
Antimalarial Treatment (provided if RDT used today is positive)					
Type of treatment provided					
Dosage					
Household Location					
Household Structure ID					
GPS Coordinates at household	Latitude:			Longitude:	